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MEMORANDUM

SUBJECT: **Aldicarb:** Drinking Water Exposure Assessment for Preliminary Risk Assessment

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This Environmental Fate and Effects Division (EFED) memorandum is a drinking water exposure assessment for the registration review of aldicarb. Aldicarb may be used on cotton, dry beans, peanuts, soybean, sugar beets, and sweet potatoes. This assessment provides estimated drinking water concentrations (EDWCs) for the total toxic residues (TTR) including aldicarb and two structurally similar degradates, aldicarb sulfoxide and aldicarb sulfone. Tier II surface water EDWCs were estimated with the Surface Water Concentration Calculator (SWCC). The Pesticide Root Zone Model-Groundwater (PRZM-GW) was used to estimate groundwater EDWCs at a pH of 6. TTR degradation varies across pH; therefore, slight acidic conditions yielded the highest concentration of aldicarb TTR in groundwater. Available monitoring data were also evaluated, however, the monitoring studies were non-targeted. Thus, these data are not expected to provide an upper bound estimate of the potential exposure to aldicarb TTR and it is recommended that the Health Effects Division adopt the EDWC generated from the modeling in this assessment. Surface water and groundwater monitoring data indicated that aldicarb and its degradates were monitored since February 1986 to December 2014. Based on the analysis of the data, even with the mitigation implemented in 2009, there is no discerning trend of decline in concentrations in groundwater.

The groundwater EDWCs are less than those for surface water; therefore, it is recommended that the EDWCs for surface water be used in future assessments conducted by the Health Effects Division. The highest one-in-ten year peak, annual mean, and 30-year mean EDWCs (187, 16, and 5.3 µg/L, respectively) are based on the labeled use of aldicarb on sugar beets at 4.05 lbs a.i./acre per year. Please note that the application rates for modeling inputs on SWCC and PRZM-GW are different due to application instructions on the label. Application rate for PRZM-GW was based on the highest application rate that is allowed for labeled use in sugar beets but the granules have to be covered with soil or drilled to a specified soil depth. Meanwhile, the application rate used for SWCC modeling was the highest rate for sugar beets that can be applied without soil cover, which significantly increases the risks of surface water exposure. Results are summarized in **Table 1**.

Table 1. Screening-Level TTR EDWCs for Proposed Uses of Aldicarb [A]

Source (Model)	Use Site (Max. Annual App. Rate)	1-in-10-year		30-Year Mean
		Peak (µg/L)	**Annual Mean (µg/L)**	
Surface water (SWCC)	Sugar beets (4.05 lbs a.i./A)[B]	**187**	16	5.3
		Peak	**Post-Breakthrough Average**	
Ground water (PRZM-GW) (pH 6)	Sugar beets (4.95 lbs a.i./A)[B]	93.2	**40**	

[A] Maximum values in bold.
[B] Application rates are different for both surface and ground water modeling because application instructions on the label specified that the 4.95 lbs a.i./A rate is covered with soil, thus minimizing surface runoff exposure, while 4.05 lbs a.i./A is the highest application rate that can be applied over irrigation furrow without soil cover, which increases potential surface water exposure.

Label Clarification:

There are some uncertainties in this assessment due to label ambiguities. The vague application instructions on the MEYMIK 15G product label are listed in the following table. The ambiguities of the instructions highly influenced the model input of the SWCC parameters and resulted in which crop was modeled, as well as the labeled application use rate. There would be less uncertainty in the exposure assessment if the label application instructions were clarified or clearly worded to eliminate confusion.

Instruction Issues	Description	Crop	Uses	Pages
"Apply granules in the seed furrow and immediately cover with soil by mechanical means"	No specification of the depth of soil needed to cover the granules or the depth of the application	Cotton, Dry Beans, Peanuts, Soybeans	At Planting (Aphids, Fleahoppers, Nematodes, Seedcorn maggot, Thrips)	7, 9, 10, 12
"Apply granules in a 4 to 6-inch band (T-Band) over open seed furrow and immediately cover	No specification of the depth of soil needed to cover the granules and no specification	Cotton	Nematodes	7

with soil by mechanical means"	on the time of application			
"Apply in seed furrow and cover with soil"	No specification of the depth of soil needed to cover the granules and no specification on the time of application	Cotton	Aphids	7
"Side dress granules in a furrow that is 6 to 10 inches to one or both sides of plant row to a depth of 2 to 3 inches. Adjust applications to minimize root pruning"	No instruction on whether to cover the granules with a given depth of soil	Cotton	Side Dress (except California)	7
"Apply granules in a 4 to 6-inch band and immediately cover with soil by mechanical means. Plant into treated zone"	No specification of how much soil is needed to cover the granules or the depth of the application	Dry Beans, Peanuts, Soybeans, Sugar Beets	At Planting / Split Application	9, 10, 12, 13
"Where furrow irrigation is used, apply granules 3 to 4 inches deep and 3 inches from seed row on the water furrow side"	The depth of soil or irrigation needed to incorporate the granules is not provided.	Dry Beans	At Planting	9
"Apply granules in a 2 to 3 inch band over seed row and immediately cover with soil by mechanical means"	No specification of the depth of soil needed to cover the granules or the depth of the application	Sugar Beets	At Planting (Sugar beet root maggot)	13
"Where furrow irrigation is employed side-dress granules 4 to 8 inches to water furrow side of plant row at furrow depth. Irrigate soon after application. Apply within 60 days after planting"	Instructions indicated no soil cover and thus expose granules to terrestrial animals or surface runoff after irrigation or precipitation event	Sugar Beets	Post Emergence	14

1. Use Characterization

Aldicarb is an insecticide, acaricide, and nematicide that is applied as granules during at-planting and/or post-emergence and in various application methods including planting in seed furrow, side dress, T-Band, and into plant canopy. There is currently only one end use product label for aldicarb, Meymik® brand 15G (Reg. No. 87895-1) which was registered in December, 2011. There are six crops listed for use of aldicarb on the Meymik label: cotton, dry beans, peanuts, soybeans, sugar beets, and sweet potatoes. **Table 2** lists the use pattern of maximum exposure for the labeled uses of aldicarb. Only ground applications are permitted. Well-setbacks are required including a 50 ft well-setback for use in ID, OR, WA; 300 ft well-setback for vulnerable soils in CO; 500 ft well-set back for vulnerable soils in MT, NE, WY. A list of the vulnerable soils provided on the Meymik 15G label is attached in **Appendix C**.

Table 2. Maximum Use Patterns for Labeled Aldicarb Use

Use	Max. Single App. Rate (lbs a.i./A)	Max. Annual App. Rate (lbs a.i./A)	Min. App. Interval (d)	App. Method	Labeled Use States
Cotton [C]	1.05 (At Planting) 0.75 (Side Dress) 2.1 (Side Dress)*	1.8 [A] 3.15* [A]	21	at-plant: in furrow and T-band post-emergent: in furrow	U.S. *[CA only]
Dry Beans	2.1	2.1 [A]	0	at-plant: in furrow	CO, ID, MI, OR, WA only
Peanuts [B]	1.05 (At Planting) 1.5 (Post-Emergence)	2.55 [A]	14	at-plant: in furrow, incorporated band or T-band post-emergent: banded over foliage	U.S. [Split application only in AL, FL, GA, NC, OK, TX, VA]
Soybeans	1.05	1.05 [A]	0	at-plant: in furrow or T-band	GA, NC, SC, VA only
Sugar Beets [D]	4.95 (At Planting) 3.0 (Post-Emergence) 4.05 (Post-Emergence) 2.1 (At Planting)* 2.1 (Side Dress)*	4.95 [A] 4.2* [A]	14	at-plant: in furrow, incorporated band or T-band post-emergent: in furrow, incorporated side band or side dress	[CO, ID, MT, NE, OR, WA, WY only] *[CA only]
Sweet Potatoes [E]	3.0	3.0 [A]	0	pre-plant or at-plant: band covered by hilling	LA, MS only

[A] Labeled use directions provide a seasonal application rate limit that approximates an annual limit.
[B] Post-emergent applications must be irrigated immediately after application. Post-emergent applications must be made to dry foliage.
[C] Second application is restricted to 0.75 lb and must be placed in furrow at least 2 inches deep. Applications must be between March 1 and September 1 in California.
[D] Applications must be made within 60 days of planting.
[E] Application must be made with positive displacement applicators.

2. Previous Drinking Water Exposure Assessments

There have been a number of drinking water exposure assessments for aldicarb. In addition, aldicarb was a component of the cumulative risks assessment, which considered all the N-methyl carbamate pesticides (Health Effects Division, 2005; OPP, 2007). Drinking water assessments conducted since 1999 are summarized below. Estimated drinking water concentrations have varied considerably across different assessments based on the available data, approved models, and labeled use patterns.

In 1999, a drinking water assessment was completed that provided estimates of aldicarb in ground water based on monitoring data, which had been summarized and analyzed by the registrant and model EDWC for surface water (Dutta, 1999). The maximum surface water EDWC as calculated by GENEEC was 88.5 $\mu g \cdot L^{-1}$. Maximum concentrations detected in monitoring data in ground water by region ranged from no detections in the Southwest to 187.2 $\mu g \cdot L^{-1}$ in New England. The GENEEC results were further refined in a separate assessment using PRZM-EXAMS modeling, which calculated EDWCs for cotton, potatoes, and citrus. Citrus had the highest EDWCs with a 1-in-10-year peak EDWC of 2.3 $\mu g \cdot L^{-1}$ (DP 247759).

Surface water estimates were updated again in the Re-Registration Eligibility Decision (RED) (DP 246901). EDWCs were calculated for citrus in Florida, potatoes in Idaho, and cotton in Mississippi. In this assessment, the highest 1-in-10-year peak EDWC was for Idaho potatoes with 17.4 $\mu g \cdot L^{-1}$. The ground water assessment was the same as that presented in the previous assessments.

The drinking water assessment in the 2003 EFED RED chapter was updated in 2005 (DP 316754). This update included an assessment of surface-water source drinking water using the total toxic residues method (TTR) for estimating the exposure from aldicarb, aldicarb sulfoxide and aldicarb sulfone combined. For surface water, 3 crops were assessed: cotton, potatoes, and citrus. Cotton had the highest 1-in-10-year peak EDWC with 14.6 $\mu g \cdot L^{-1}$. For ground water, SCI-GROW estimates were calculated for the same 3 crops, with citrus having the highest EDWC at 4.95 $\mu g \cdot L^{-1}$. The ground water monitoring data were reassessed and some newer data were added to previous assessments. These newer data showed that concentrations in ground water in excess of 20 $\mu g \cdot L^{-1}$ were being found in the early 1990s.

The drinking water exposure assessment for aldicarb was updated in 2006 (DP 333309). This assessment included aldicarb sulfoxide and sulfone as well as parent aldicarb. This was done to be consistent with the N-methyl carbamate cumulative assessment. Typical use rates were assessed rather than maximum label rates. Both surface and ground water sources were assessed. A refined modeling approach was used for both ground water and surface water. Peanuts, cotton, citrus and potatoes were the uses assessed. For ground water, well setback distances were estimated using a high-end estimate of lateral ground water movement. The maximum EDWCs were for citrus in Florida for surface water with 10.2 $\mu g \cdot L^{-1}$ for a 30 year maximum concentration and for peanuts in Georgia for ground water with 6.5 $\mu g \cdot L^{-1}$ for a 30 year maximum concentration with a 30 ft buffer in place around the well.

Aldicarb was considered as part of two cumulative risk assessments for the N-methyl carbamate insecticides. A preliminary assessment (Health Effects Division, 2005) included aldicarb, carbaryl, carbofuran, formetenate, methomyl, oxamyl, propoxur, methiocarb, pirimicarb, and thiodicarb. The assessment looked at three routes of exposure; dietary from food, dietary from drinking water, and residential exposure.

The drinking water component of the preliminary assessment focused on areas where combined N-methyl carbamate (NMC) exposure is likely to be among the highest within each region as a result of total NMC usage and vulnerability of drinking water sources. This analysis was based on a probabilistic modeling approach that considers the full range of data. Exposures in drinking water to individuals were incorporated into the cumulative exposure assessment on a regional- and source water-specific basis (*i.e.*, ground water and surface water, by region). The regional drinking water exposure assessments are intended to represent exposures from vulnerable drinking water sources resulting from typical NMC usage and reflect seasonal variations as well as regional variations in cropping and NMC use. In most of the country, NMC residues in drinking water sources are at levels that are not likely to contribute substantially to the multi-pathway cumulative exposure. However, it was found that NMC residues estimated for vulnerable private wells in some areas of Florida (primarily along the central ridge) and the southeastern coastal plain are major contributors to the cumulative NMC exposures.

The revised N-methyl carbamate cumulative assessment (OPP, 2007) reflected some changes due to updates in the fate and transport data for some compounds due to the completion of the single chemical assessments, but also reflected changes in use patterns that had been implemented or were expected to occur as a result of the re-registration process. These included restrictions on the use of aldicarb in Florida and the Atlantic Coastal Plain to protect ground water, the expected cancellation of carbofuran and the restrictions of the use of other N-methyl carbamates. The methods used in the revised assessment were essentially the same as those used in the preliminary assessment. This assessment that cumulative risks were below levels of concern if carbofuran was cancelled and certain uses for pesticides other than aldicarb were removed (*e.g.,* methomyl on grapes).

The current assessment reflects use directions on the only registered label for aldicarb and utilizes the current risk assessment methods and models.

3. Environmental Fate Characterization

Aldicarb degrades to aldicarb sulfone and aldicarb sulfoxide, primarily by aerobic soil metabolism (parent half-lives range from 1 to 28 days in a variety of soils). Aerobic soil metabolism half-lives for the combined residues (i.e., aldicarb, sulfoxide, sulfone) range from 11 to 136 days, with a 90th percentile upper bound on the mean of 55 days. This is within the range observed in published field studies, where dissipation half-lives for total toxic residues ranged from approximately 0.3 to 5 months in the unsaturated zone, and 1 to 36 months in the saturated zone (Jones and Estes, 1995).

Aldicarb is relatively stable to hydrolysis, slowly hydrolyzing only at a pH of 9 (MRID 00102065). Aldicarb sulfoxide hydrolyzed more quickly ($t_{1/2}$ = 2 - 3 days) at pH 9 than at pH 7 (about 6% at 28 days) (MRID 00102066). Aqueous photolysis rapidly degraded aldicarb to oxime and nitrile forms (*i.e.* with a $t_{1/2}$ of 4 days: MRID 42498201). However, this process will only be dominant in clear, shallow waters, and will not affect residues in the subsurface.

Aldicarb and its degradates are highly mobile in soil. Freundlich K_{ads} values ranged from 0.20 to 0.60 mL/g for aldicarb (MRID 42498202), 0.17 to 0.36 mL/g for aldicarb sulfoxide (MRID 43560301), and 0.12 to 0.22 mL/g for aldicarb sulfone (MRID 43560302).

The lines of evidence from available registrant-submitted studies, published literature, and monitoring data indicate that the total toxic residues of aldicarb will degrade slowly in upper soil layer, move fairly rapidly into the subsurface (the rate of movement depending upon the permeability of the soil and amount of excess water that moves through the soil), and potentially persist in the subsurface and ground water under acidic (pH<7) conditions. The sulfoxide and sulfone degradates will hydrolyze rapidly in alkaline soils, so the ultimate fate in ground water will depend upon the pH of the soil, vadose zone, and aquifer.

Table 3 include the environmental fate data for aldicarb (parent only) and total residues while **Table 4** lists the environmental fate data of aldicarb sulfoxide and aldicarb sulfone.

Table 3. Chemical Properties and Environmental Fate Parameters of Aldicarb

Parameter	**Value**	**Reference**
	Physical/Chemical Parameters	
Molecular mass	190.26 g/mol	Calculated
Vapor pressure (23°C)	6.25×10^{-6} torr	MRID 4822504
Henry's Law constant (23°C)	3.0×10^{-10} atm·m^3/mol	Calculated
Water solubility (pH 7, 25°C)	6,000 mg/L	MRID 4822504
Octanol-water partition coefficient (K_{OW})	11.48	MRID 4822504
	Persistence in Water	
Hydrolysis half-life	pH 5: no significant degradation @ 30 d pH 7: no significant degradation @ 30 d pH 9: < 10% degradation of parent @ 30 d $T_{1/2}$ < 197 d	MRID 00102065
Aqueous photolysis half-life	4 d	MRID 42498201
	Persistence in Soil	
Aerobic soil metabolism half-life [25°C]	*parent only*: NJ sandy loam: 2.3 d Houston clay: 11 d Lakeland sandy loam: 17 d Norwood silty clay: 12 d unspecified: 1 d Illinois silt: 6 d NC loamy sand: 10 d *total toxic residues:* Houston clay: 28 d Lakeland sandy loam: 47 d Norwood silty clay: 136 d unspecified: 44 d	 MRID 44005001 MRID 00093642 MRID 45602904 MRID 45739801 MRID 00093642 MRID 45602904

Parameter	Value	Reference
Mobility		
Fruendlich Adsorption Coefficients (K_f)	*parent* sandy loam: 0.186 $L \cdot kg^{-1}$ silt: 0.36 $L \cdot kg^{-1}$ clay: 0.6 $L \cdot kg^{-1}$ sand: 0.2 $L \cdot kg^{-1}$	MRID 42498202 MRID 43560301 MRID 43560302

Table 4. Environmental Fate Parameters for Aldicarb Sulfoxide and Aldicarb Sulfone

Fate Endpoint	Aldicarb sulfoxide	Aldicarb sulfone
Hydrolysis – pH 5		495 d (MRID 45592104)
Hydrolysis – pH 7	6% loss at 30 d (MRID 00102066)	63 d (MRID 45592104)
Hydrolysis – pH 9	2.3 d (MRID 00102066)	1 da @ 25°C; 32 d @ 5°C (MRID 45592104)
Hydrolysis in published literature: Lemley & Zhong, 1983 (45602901); Hansen & Spiegel, 1983 (45602902); Lemley & Zhong, 1984 (45602903)	Hydrolysis is sensitive to hydroxide concentration (base-catalyzed), with sulfone most sensitive and aldicarb least (Lemley & Zhong, 1983). Aldicarb hydrolysis rates increase at pH levels >7.5; sulfoxide and sulfone hydrolyze more readily and are affected by pH and temperature (results for 5, 15 °C) (Hansen & Spiegel, 1983). Both pH and temperature dependence seen in hydrolysis of all 3 chemicals. Rates for sulfone at 25 °C 60 d @ pH7, 6 d @ pH8 (Lemley & Zhong, 1984)	
Aqueous photolysis		123 d (12 hr light/dark) (MRID 45592105)
Aerobic soil metabolism (MRID 44005001)	Concentrations fluctuated between 9-86% of applied from 7-60 day post treatment	Concentrations fluctuated between 3-80% of applied from 7-60 day post treatment
Aerobic soil metabolism range (MRID 00101934)	Total carbamate residues (parent, sulfoxide, sulfone) 11 – 110 d in 2 soils x 3 pH x 2 moisture contents; avg 34 d; 90% upper confidence bound 48 d	
Aerobic soil metabolism	5 d (MRID 45592108)	3.33 d half-life (pH 6.7 soil) (MRID 00053370)
	Total carbamate residues (parent, sulfoxide, sulfone) 28, 47, 136 for 3 soils (MRIDs 00093642, 00080820, 00093640, 00053366)	
Lab studies of all 3 forms (Lightfoot *et al*, 1987; Bank & Tyrrell, 1984) [A]	Combined residues (aldicarb, sulfoxide, sulfone) degraded to oximes, nitrile with half-lives up to 3 months; soil-catalyzed hydrolysis, not aerobic metabolism was driving factor.	
Lightfoot *et al*, 1987 (MRID 45602904)	Combined (parent+degradate): 44 (unsterilized) – 10 (sterilized) d surface soil 123 (unsterilized) – 16 (sterilized) d subsurface soil	

Aerobic soil metabolism, 2002 registrant submissions (MRID 45739802)		15.2 d in IL silt (pH 7.9); 91.2 d in NC loamy sand (pH 6.2).
Aerobic soil metabolism literature (Smelt et al, 1983)	sulfone & sulfoxide half-lives in Dutch subsoils from 2-131 d under anaerobic cond., 84-1100 d under aerobic condition	
Aerobic aquatic metabolism, 2002-3 registrant submissions	5 d (total system) in pH 7.0 water / pH 6.3 sediment (MRID 45592108)	3.5 d (total system) in pH 7.0 water / pH 6.3 sediment (MRID 45592109)
Anaerobic aquatic metabolism	3.4 d (MRID 45592110)	3.5 d (MRID 45592111)
Published field studies (Jones & Estes, 1995)	Summarized results of 32 field studies for aldicarb in 24 locations. Half-life of total carbamate residues (aldicarb, sulfoxide, sulfone) in surface soil ranged from 0.3 to 3.5 months; mean 1.3 mo (40 d) & 90% upper confidence bound on mean 1.5 mo (45 d). In 2 studies, estimated subsurface half-life of 5 months.	
Fruendlich Adsorption Coefficients (K_f) (MRID 42498202, 43560301, 43560302)	*aldicarb sulfoxide* ($L \cdot kg^{-1}$): Tujunga loamy sand: 0.22 Wedowee sandy loam: 0.17 Huntington silt loam: 0.26 Huntington sandy clay loam: 0.26	*aldicarb sulfone* ($L \cdot kg^{-1}$): Tujunga loamy sand: 0.09 Wedowee sandy loam: 0.12 Huntington silt loam: 0.22 Huntington sandy clay loam: 0.22

[A] Study looks at degradation of aldicarb and total carbamates (parent, sulfoxide & sulfone) in surface soil, soil water, distilled water, saturated zone soil in sterilized/unsterilized conditions

4. Exposure Modeling

The available physical/chemical and environmental fate properties of aldicarb and its degradates of concern were used to calculate exposure model input parameters to derive EDWCs.

4.1. Residues of Concern (TTR)

The aldicarb residues of concern include the parent compound and two structurally similar degradates: aldicarb sulfoxide and aldicarb sulfone (Health Effects Division, 2005; Reregistration Eligibility Decision for Aldicarb, 2007). Since both degradates exhibit similar fate characteristics and toxicity to that of aldicarb, a Total Toxic Residue (TTR; *Ruhman, M., draft document*) approach was used for modeling exposure to all three residues. To account for total toxic aldicarb residues, each relevant environmental fate study (hydrolysis, aqueous photolysis, aerobic soil metabolism, etc.) are used to calculate the amount of aldicarb, aldicarb sulfoxide, and aldicarb sulfone present in each study at each sampling interval. The total concentrations are used to recalculate the rate constant and the corresponding half-life value for each study.

4.2. Surface Water

The TTR modeling approach was used to estimate aquatic exposure using TTR half-life values (from **Table 4**), and aldicarb soil mobility and chemical properties (from **Table 3**).

Chemical property and environmental fate input values were chosen in accordance with current input parameter guidance (USEPA, 2009).

Surface water source drinking water exposure was estimated using the Tier II exposure model SWCC (v1.106). Chemical input parameters for SWCC follow in **Table 5**.

Aldicarb use on peanuts, cotton, dry beans, soybeans, and sugar beets were modeled considering maximum single and annual application rates, as well as minimum retreatment intervals. The rates and uses in corresponding states are listed on **Table 2**. A drinking water intake percent cropped area (PCA) adjustment factor of 1 was utilized in this assessment because aldicarb may be used on multiple crops (Brady, 2014). Regional EDWCs were derived based on HUC 2 region drinking water intake PCAs, considering the geographic limitation of aldicarb use. The results are listed in **Appendix B**.

Aldicarb use on sweet potatoes were not modeled because the application instruction requires the granules to be covered to a sufficient soil depth (8-10 inches hilling or bed forming process) limiting runoff, thus reducing the potential surface water exposure[1]. In addition, since drift is not expected from granular application of aldicarb, offsite exposure is expected to be minimal for this use.

Table 5. SWCC Chemical Input Parameters for Aldicarb TTR [A]

Input Parameter	Value	Justification	Source
K_d (mL/g)	0.16	Mean value for aldicarb, its sulfoxide and its sulfone	MRID 42498202 43560301 43560302
Aerobic aquatic metabolism half-life (days) [Temp. (°C)]	12 [25]	Single acceptable guideline study for aldicarb TTR (4 days) x 3	MRID 44592107
Anaerobic aquatic metabolism half-life (days)	24	No data; use 2X aerobic aquatic half-life	Calculated
Aqueous photolysis half-life (days) [Ref. Latitude (°)]	4 [40]	Represents the single value for the residues of concern	MRID 42498201

[1] The SWCC only considers runoff in the top 4 cm for ground applications; therefore, no runoff would result from modeling this scenario.

Input Parameter	Value	Justification	Source
Hydrolysis half-life (days)	pH 5: 0 pH 7: 0 pH 9: 60	Represents the value for aldicarb TTR	MRID 00102065
Aerobic soil metabolism half-life (days) [Temp. (°C)]	55 [25]	Represents the upper 90% confidence bound on the mean for combined aldicarb TTR half-lives from 19 soils	MRID 00102051, 00093642, 00080820, 00093640, 00053366, 00101934, 00035365, 00102071
Foliar half-life (days)	0	Default value in the absence of data	USEPA, 2012
Molecular mass (g/mol)	190.3	Molecular mass of aldicarb	Calculated
Vapor pressure (torr) (25°C)	6.3×10^{-6}	Study value for aldicarb	MRID 00152095
Solubility in water (mg/L) (25°C)	6,000	Study value for aldicarb	Acc 255979

[A] Source data are in **Tables 3 and 4**.

Use Pattern Inputs

SWCC use pattern inputs are listed in **Table 6**. Modeled SWCC scenarios were those applicable to the labeled use sites that are expected to result in the highest exposure. Maximum labeled application rates and numbers of applications per year along with minimum retreatment intervals allowed on the label were modeled. Dates of initial application were selected within the scenario crop season and characterized by vulnerability to runoff. The date resulting in the highest exposure estimates is reported. This is expected to produce high-end exposure estimates that are conservative.

Table 6. SWCC Scenarios and Input Parameters Describing Maximum Patterns of Aldicarb Use on Representative Use Sites [A]

Use Site (Labeled Use)	SWCC Scenario	Date of App.	App. Rate in lbs a.i./A (App. Time)	App. per Year	App. Interval (days)	CAM Input	PCA (%)	Application Efficiency/ Spray Drift
Cotton	CA cotton	Apr. 4 Apr. 25	1.05 (At Planting) 2.1 (Side Dress)	2	21	1	100	0.99/0
	NC cotton	Sep. 1 Sep. 22	1.05 (At Planting) 0.75 (Side Dress)					
	MS cotton	Apr. 1 Apr. 22						
Dry Beans	MI beans	Apr. 1	2.1 (At Planting)	1	NA	1		
	OR snbeans							
Peanuts	NC peanuts	Apr. 1 Apr. 15	1.05 (At Planting) 1.5 (Post Emergence)	2	14	7 2		

Use Site (Labeled Use)	SWCC Scenario	Date of App.	App. Rate in lbs a.i./A (App. Time)	App. per Year	App. Interval (days)	CAM Input	PCA (%)	Application Efficiency/ Spray Drift
Soybeans	MS soybeans	Apr. 1	1.05 (At Planting)	1	NA	1		
Sugar Beets	MN sugar beets	Apr. 15	4.05 (Post Emergence)					

*NA = Not Applicable
[A] Source data are in **Table 2**.

Surface Water Results

The 1-in-10-year peak, 1-in-10-year peak annual average, and 30-year mean exposure estimates in surface water drinking water sources for aldicarb TTR are listed in **Table 7**. Model input and output files are attached in **Appendix A**. The maximum labeled use pattern on sugar beets resulted in the highest EDWCs. These exposure estimates are adjusted by the national PCA applicable to the use.

Table 7. SWCC Output (PCA-adjusted) for Aldicarb TTRs [A]

Use Site	PRZM Scenario	PCA [C]	pH [B]	1-in-10-year Peak (µg/L)	1-in-10-year Annual Average (µg/L)	30-year Mean (µg/L)
Cotton	CA cotton	100	7	23.1	1.75	0.45
	NC cotton			51.1	3.65	1.71
	MS cotton			84.1	5.64	2.18
Dry Beans	MI beans			73.1	7.35	2.68
	OR snbeans			70.3	6.52	1.83
Peanuts	NC peanuts			50.4	4.01	1.29
Soybeans	MS soybeans			63.7	3.72	1.09
Sugar beets	MN sugar beets		7	**187**	**16**	**5.3**
			9	187	12	3.87

[A] Maximum values are in bold
[B] pH is based on the value of hydrolysis half-lives of aldicarb TTR
[C] The PCA is the national PCA applicable to the use.

For characterization, surface water exposure was estimated for aldicarb TTR, taking into account for degradates, sulfoxide and sulfone. Since degradation of aldicarb TTR is driven by pH-dependent hydrolysis (especially in alkaline conditions), both pH 7 and 9 hydrolysis values of aldicarb TTR were assessed, where hydrolysis input rate of pH 7 is 0 days (no significant degradation) and pH 9 is 60 days. Using sugar beets as an example, SWCC output shows similar peak concentrations of pH 7 and 9, both at 187 µg/L. Larger differences were shown with annual average and 30-year average, where pH 7: 9 (16:12 µg/L) is 25% and pH 7: 9 (5.3:3.9 µg/L) is 26%, respectively. These results however, show that hydrolysis has minimal impact on the resulting surface water exposure estimate.

4.3. Ground Water

4.3.1. PRZM-GW

PRZM-GW inputs are listed in **Table 8**. Aldicarb use on sugar beets were modeled because it has the highest application rates (**Table 2**). Application inputs represent the use pattern of sugar beets for maximum exposure, which is two applications per year, each at 2.774 kg a.i./hectare, 14 days apart. The initial date of application (April 1) is within the application season and selected to result in high-end concentrations in ground water due to vulnerability to precipitation.

PRZM-GW was used to simulate transport processes through high leaching potential soils to a shallow unconfined aquifer with a water table at 9 meters (~ 33 feet) below the surface. The well screen extended an additional 1 m below the water table. This assessment follows the refined ground water exposure approach used for the aldicarb RED (USEPA OPP EFED, 2006; USEPA OPP, 2007a), the N-methyl carbamate cumulative risk assessment (USEPA OPP, 2007b), the Drinking Water Exposure Assessment for proposed expansion of aldicarb use on potatoes into 6 additional states (CO, MI, MN, ND, SD, WY) (USEPA OPP EFED, 2008), and the Tier 2 Drinking Water Assessment Tobacco Uses of aldicarb and its major degradates aldicarb sulfoxide and aldicarb sulfone (USEPA OPP EFED, 2009).

The well concentration is the average pore water concentration across the length of the screen. PRZM was set up to deliver the average pore water concentration in the 'saturated' soil profile in the upper meter of the ground water zone.

The modes and rates of degradation for aldicarb residues changed through the soil profile. The aerobic soil metabolism rate for the top 25 cm is used with linearly rate decrease with increasing depth to 1 m. Below that, only the rate of hydrolysis. **Table 8** summarizes the pertinent aldicarb properties used for this assessment. These properties came from an evaluation of registrant-submitted studies. Properties for aldicarb represent total residue (parent aldicarb, plus the degradates aldicarb sulfoxide and aldicarb sulfone) properties.

Table 8. PRZM-GW Input Parameters for Aldicarb [A]

Input Parameter	Value	Justification	Source
Application Rate (kg a.i./ha)	2.774	Maximum labeled single split application rate for sugar beets: Meymik® brand 15G Aldicarb label (EPA Reg. No. 87895-1)	Meymik 15G labeled use
Applications per Year	2; every year	Maximum number of applications per year at the maximum application rate	
Reapplication interval (days)	14	Minimum labeled interval between pre- and post-emergence	
Initial application date	Apr. 1	Selected within application season and for high-end vulnerability due to precipitation	Estimated
Application Method	@ Depth (# 5)	As stated on label as to be applied at plant as granules in bands or furrows and then covered with soil for the estimated incorporation depth	Meymik 15G labeled use and estimated depth
Incorporation Depth (cm)	2		
Efficiency	0.99	Label stated exclusively for ground use only	Meymik 15G labeled use
Drift	0	Label stated that active ingredient and formulation are in granular form, thus no spray drift	
Hydrolysis Half-life (days)	495 d @ pH 5 (measured) 152 d @ pH 6 (estimated) 63 d @ pH 7 (measured) 6 d @ pH 8 (measured) 1 d @ pH 9 (measured)	Represents the value for the total residues of concern (TTR). Based on sulfone rates for combined degradates, below 100 cm. Parent hydrolyzed only at pH 9. Sulfoxide 2-3 days @ pH9	MRID 00102065
Surface Soil Half-life (days)	55	Represents the upper 90% confidence bound on the combined parent + sulfoxide + sulfone (TTR) half-life from 19 soils, for the top 25 cm. Decreased linearly from 25 to 100 cm.	MRID 00102051 00093642 00080820 00093640 00053366 00101934 00035365 00102071
K_d (ml/g)	0.12 K_{OC}= 10 mL/g	Represents the value for aldicarb sulfone	MRID 43560302
Additional Notes	Modeled total aldicarb residues (TTR)	Half-life values used in inputs based on combined aldicarb + sulfone + sulfoxide residues; lowest K_d of the 3 chemicals used for mobility. Assumes equal toxicity of parent, degradates	

[A] Source data are in **Tables 2, 3, and 5**.

Hydrolysis half-life of combined aldicarb residues in groundwater was estimated based on aldicarb sulfone because parent compound only hydrolyzes at pH 9 and aldicarb sulfoxide hydrolyzes rapidly only at pH 9 but only 6% at 30 days on pH 7. Furthermore, aldicarb sulfone is the terminal toxic degradate of parent aldicarb and is of core concern due to its mobility and persistence in subsurface conditions.

EPA estimated the hydrolysis half-life at pH 6 using the measured rates at pH values of 5, 7, and 9 and the following equations to solve for the acid- (ka), neutral- (kn) and base- (kb) catalyzed hydrolysis rate constants:

(1) $K_{pH5} = ka(10^{-5}) + kn + kb(10^{-9})$
(2) $K_{pH7} = ka(10^{-7}) + kn + kb(10^{-7})$
(3) $K_{pH9} = ka(10^{-9}) + kn + kb(10^{-5})$

Once the three rate constants are determined, the overall hydrolysis rate at any pH can be determined using the following equation:

(4) $K_{pHX} = ka[H^{+}] + kn + kb[OH^{-}]$

This resulted in a rate constant of 0.00456 and a $T_{1/2}$ of 152 days for aldicarb sulfone at pH 6.

Estimated aldicarb residues in ground water are based on the labeled maximum annual application rate of 4.95 lb ai/acre for sugar beets, applied twice (with split applications of 2.774 lb ai/acre) during at plant and post-emergence as granules in bands or furrows and covered with soil.

To account for the well setback distances specified on the Meymik 15G label, EFED used a plug flow model to simulate the additional travel time for a pesticide to reach a drinking water well from point of application. This is explained in detail in the preliminary NMC cumulative assessment (USEPA/FIFRA SAP, 2005). Well setback distances result in additional travel time for the chemical to move laterally to the well. This results in additional degradation. Reductions in concentration are calculated in these assessments by a plug flow approximation:

[EMBED Equation.3]

where C = concentration at well [mass/volume]
C_0= concentration at point of application [mass/vol]
L = well setback distance [length]
v = lateral ground water velocity [length/time]
k = degradation rate in aquifer [$time^{-1}$]

For the ground water exposure assessment, EFED used the reduction factor associated with several of the corresponding well-setback distances on the Meymik 15G label (50 ft for soils in ID, OR, WA; 300 ft for vulnerable soils in CO; 500 ft for vulnerable soils in MT, NE, WY). The reduction factor is based on a typical high-end lateral ground water velocity of 0.305 m/da (1 ft/da) as recommended in the PRZM-GW guidance document (USEPA. 2012*b*).

Estimated Total Aldicarb Residues in Ground Water

PRZM-GW outputs are listed in **Table 9**. EFED compared the distributions of total aldicarb residues in groundwater over the environmentally relevant pHs of 6, 7, and 8 because degradation of aldicarb residues is heavily driven by pH-dependent hydrolysis in the subsurface, specifically in alkaline conditions. These pH ranges serves a proper representation of the groundwater pH scenarios in Idaho, Oregon, and Washington State. These states have a minimum well setback distance of 50-foot well setback was specified on the label. Despite the soil types in Idaho, Oregon, and Washington state being different than that of the modeled scenarios, EFED considers these scenarios as the best surrogates to represent vulnerable soils.

EFED recognizes that the scenarios used in modeling aldicarb has its limitations and some of the soil names used in the model scenarios are listed in the Meymik label with additional restrictions and could be disputed for use in modeling. However, these PRZM-GW scenarios and soil types were developed and simulated as proxies with conservative approach to best represent the most vulnerable soils with high leaching potential and shallow groundwater table in order to account for groundwater contamination risks.

PRZM-GW outputs for the minimum 50-foot well setback for labeled use in Idaho, Oregon, and Washington yielded the highest estimated concentration with FL Central Ridge scenario in the range of 1.62 – 93.2 μg/L and 0.0033 – 40 μg/L for maximum daily concentration and post-breakthrough mean, respectively, within the environmentally relevant groundwater pH range of 6, 7, and 8. However, the highest mean breakthrough time is 11.9 years with the Wisconsin Central Sands scenario. These results should be interpreted in the context of the pH range because groundwater pH can vary even within the same region or aquifer.

Table 9. PRZM-GW Output for Aldicarb TTR[A]

Use Crop	Modeled Scenario (ID, OR, WA)	Well Setback (ft)	Ground water pH	Max. Daily Conc. (µg/L)	Mean Breakthrough Time (yrs)	Post-breakthrough Mean (µg/L)
Sugar Beets	DEMARVA	50	6	54	5.5	33
			7	9.3		3.5
			8	3.8E-03		2.7E-05
	FL Central Ridge	50	6	**93.2**	3.4	**40**
			7	**33.6**		**5.8**
			8	**1.62**		**3.3E-03**
	FL Jacksonville	50	6	53	2.7	25
			7	15.1		4.2
			8	1.09		3.0E-03
	GA Southern Coastal Plain	50	6	6.6	5.4	2.5
			7	0.46		0.06
			8	2.0E-07		5.8E-10
	NC Eastern Coastal Plain	50	6	4.2	9.0	2.6
			7	0.26		0.08
			8	8.84E-05		5.9E-07
	WI Central Sands	50	6	21	**11.9**	15.9
			7	0.85		0.43
			8	1.0E-06		1.9E-08

[A] Maximum values are in bold.

PRZM-GW outputs for varying distance of well setbacks which were specifically stated on the label for sugar beets use in the states of CO, MT, NE, and WY are listed in **Table 10**. The highest concentration of total aldicarb residues generated with Florida Central Ridge scenario at pH 6 illustrated that increasing distance in well setback resulted in significant decreased of aldicarb concentration.

Table 10. Estimated concentrations of total aldicarb residues in different well setback distances in states specified on the label.

Use Crop	Modeled Scenario	Well Setback (ft)	Ground water pH	Max. Daily Conc. (µg/L)	Mean Breakthrough Time (yrs)	Post-breakthrough Mean (µg/L)
Sugar Beets	FL Central Ridge (CO)	300	6	4.0	3.4	1.72
	FL Central Ridge (MT, NE, WY)	500	6	0.32	3.4	0.14

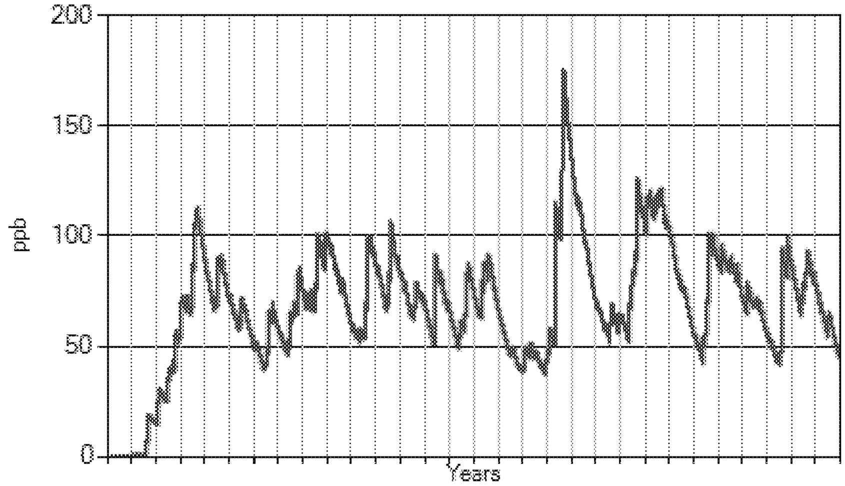

Figure 1. Groundwater EDWCs (µg/L) per Time (years) for the Florida Central Ridge (pH 6)

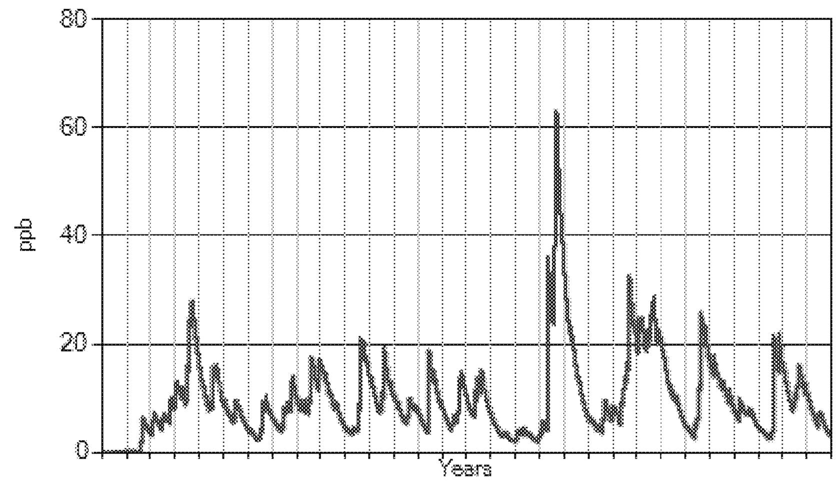

Figure 2. Groundwater EDWCs (µg/L) per Time (years) for the Florida Central Ridge (pH 7)

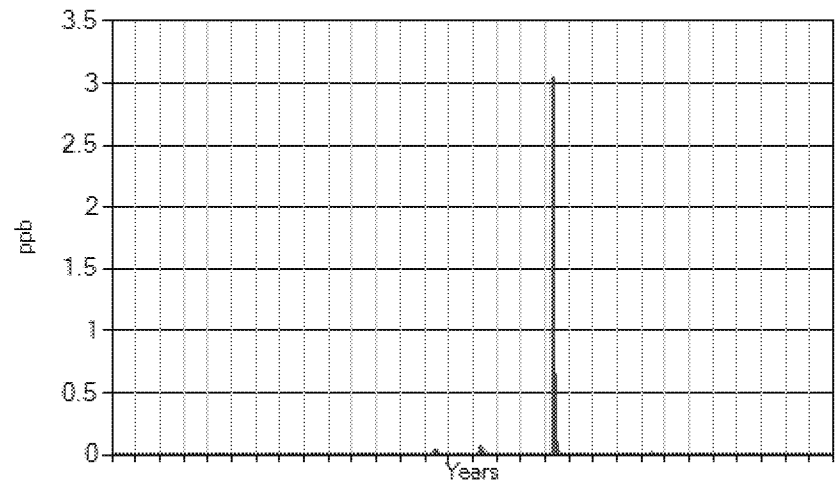

Figure 3. Groundwater EDWCs (µg/L) per Time (years) for the Florida Central Ridge (pH 8)

Figure 1, 2, & 3 displays ground water concentrations over time for the Florida citrus scenario in slight acidic, neutral, and slight alkaline conditions (pH 6, 7, & 8). **Figure 1** shows that under slight acidic condition, aldicarb TTR is persistent, hydrolyzes slowly and averaged between 50 to 100 µg/L with a peak of ~175 µg/L over 100 simulated years. Under neutral condition (pH 7) in **Figure 2**, aldicarb TTR follows the pattern of pH 6 but with concentrations fluctuate within 10 to over 20 ppb with the spike of over 60 ppb. In slight alkaline conditions (**Figure 3**), aldicarb TTR hydrolyzes quickly to under 0.1 ppb but peaked at 3 ppb in a high precipitation event.

5. Modeling Results Summary

The reported EDWCs are upper bound estimates that were derived using conservative model input assumptions related to the environmental fate of aldicarb as well as the proposed use patterns. The EDWCs represent the potential exposure to aldicarb in a rural drinking water well beneath an agricultural field (a high pesticide use area), which draws water from an unconfined, high water-table aquifer that is used as source drinking water. Vulnerable groundwater supplies are highly localized; therefore, the EDWCs are not expected to represent actual drinking water concentrations resulting from the proposed use across the entire country but rather provide an upper bound exposure estimate for use in the new chemical dietary risk assessment that represent the potential exposure to a subset of the U.S. population. The USGS indicates that 14% (42,900,000) of the US population derives their drinking water from self-supplied sources with groundwater being the dominant source.[1] Moreover, the EDWCs are not intended to represent the exposure to individuals drinking from publically supplied water that is sourced from confined aquifers. However, confined aquifers may be vulnerable to aldicarb contamination if natural or man-made preferential flow pathways exist. In addition, high-volume pumping (e.g., irrigation) in confined aquifers can create a significant downward hydraulic gradient between an overlaying unconfined aquifer and a confined aquifer. [1]

Table 11 summarizes the screening-level exposure model results for aldicarb TTRs.

Table 11. Screening-Level TTR EDWCs for Aldicarb Uses [A]

Source (Model)	Use Site (Max. Annual App. Rate)	1-in-10-year		30-Year Mean
		Peak (µg/L)	Annual Mean (µg/L)	
Surface water (SWCC)	Sugar beets (4.05 lbs a.i./A)[B]	**187**	16	5.3
		Peak	**Post-Breakthrough Average**	
Ground water (PRZM-GW) (pH 6)	Sugar beets (4.95 lbs a.i./A)[B]	93.2	**40**	

[A] Maximum values in bold. "N/A" means "not available."

[B] Application rates are different for both surface and ground water modeling because application instructions on the label specified that the 4.95 lbs a.i./A rate is covered with soil, thus minimizing surface runoff exposure, while 4.05 lbs a.i./A is the highest application rate that can be applied over irrigation furrow without soil cover, which increases potential surface water exposure.

6. Monitoring Data

Included in this assessment are available data on aldicarb, aldicarb sulfone, and aldicarb sulfoxide (aldicarb residues of concern) from non-targeted monitoring conducted in the following water monitoring programs and registrant submitted studies: the California Department of Pesticide Regulation (CDPR) surface water database ([HYPERLINK "http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm"], the USGS NAWQA surface and ground water database ([HYPERLINK "http://cida.usgs.gov/nawqa_queries_public/"]), the USEPA STORET Data Warehouse ([HYPERLINK "http://www.epa.gov/storet/"]), and the Bayer CropScience monitoring studies.

6.1. USEPA STORET Data Warehouse

STORET data indicate that all 50 states in the U.S. including the District of Columbia were monitored for aldicarb, aldicarb sulfone, and aldicarb sulfoxide at various times from February 1986 to December 2014. A total of 12310 samples were collected from 7041 sites, with parent aldicarb, sulfoxide, and sulfone sample collection numbered at 3966, 4219, and 4125, respectively. Aldicarb residues were detected in 222 samples with a detection percentage of 1.8% out of the total samples. The lowest range of detection level was 0.0009 µg/L and the highest detected concentration was 9.0 µg/L.

6.1.1. USEPA STORET Surface Water Data

On surface water data, a total of 9,045 samples were collected for aldicarb and its residues. The greatest frequencies of detections for surface water were in the Southwestern U.S. and California. Parent aldicarb and sulfone was detected simultaneously in one surface water sample with a concentration of 0.5 and 0.4 µg/L, respectively in San Miguel County, New Mexico on August 2001. Sulfoxide was detected in a total of five samples with the highest concentration at 0.3 µg/L in San Miguel, New Mexico on August 2001. The other four samples were found within the range of 0.0173-0.111 µg/L between May 2004 to April 2006 in Mohave, San Diego, and Alameda Counties, California (U.S. Geological Survey 2015).

6.1.2. USEPA STORET Ground Water Data

A total of 3,265 samples were collected for aldicarb and its residues. The vast majority of detection frequencies were in the Southeastern U.S., especially in Collier County, Florida. Parent aldicarb was found in 151 samples from different sites in Collier County, except for one from Glades County, Florida. Parent aldicarb was detected twice at 62 different sites in Collier County, Florida at the concentration of 0.18µg/L between February to October 2008, prior to implementation of mitigation plan. Aldicarb, aldicarb sulfoxide, and aldicarb sulfone were detected once in 29 different sites in Collier County, Florida between February to May 2012 at the concentration of 0.64, 0.30, and 0.35 µg/L, respectively. The earliest and highest detection of sulfoxide was measured at 2.6 µg/L in Yuma, AZ on January 1997. All other 29 sulfoxide samples were at 0.3 between March – May 2012 in Collier County, Florida. Aldicarb sulfone was first detected on January 1997 in Yuma, Arizona with the highest concentration of 9.0 µg/L. All the subsequent detections of sulfone (30 samples) were in Collier County, Florida within the months of February to May 2012 at concentration 0.35 µg/L (U.S. Geological Survey 2015).

6.1.3. USEPA STORET Monitoring Data Summary

Monitoring data for both STORET surface and ground water results indicated that the monitoring is non-targeted and while some sites were sampled twice or more than ten times but the overwhelming majority were sampled only once. The timing of the monitoring was irregular as well. Some sites were monitored for several consecutive years, however, many sites with detected aldicarb and residues were only sampled once and no follow-up monitoring. Hence, the data cannot be correlated with aldicarb use.

6.2. USGS NAWQA Surface and Ground Water Data

NAWQA data indicate that 50 states in the U.S. and the District of Columbia except for Kentucky were monitored for aldicarb, aldicarb sulfoxide, and aldicarb sulfone at various times from May 1992 to December 2013. A total of 44298 samples were collected from 6587 sites. The total number of parent aldicarb, sulfoxide, and sulfone detections and percentage per total number sampled were 231 and 0.5%, respectively.

Parent aldicarb, sulfoxide, and sulfone detections in surface and ground water monitoring data are summarized in their individual sections in the following:

6.2.1. Aldicarb

6.2.1.1. Surface Water Monitoring Data

Criteria	Data
Number of Surface Water Detections	54 (8,456 Total Samples)
Lowest Surface Water Detection	0.08 µg/L (Weld County, CO; July 1994)
Highest Surface Water Detection	**2.21** µg/L (Sumter County, GA; September 1993)
Earliest Detection	0.34 µg/L (Beaufort County, NC; April 1993)
Latest Detection	0.1625 µg/L (Washington County, MS; May 2005)

State	County	Detection Numbers	Concentration (µg/L)	Collection Date Range
AL	Russell, Houston, Henry	4	0.28 - 0.37	June 1993
CA	Merced	1	0.46	April 1993
CO	Weld	1	0.08	July 1994
GA	Baker, Carroll, etc. (21 Counties)	41	0.26 - 0.9	Jun – Nov 1993
	Cobb*	1	**1.47**	Nov 1993
	Sumter*	1	**2.21**	Sep 1993
MS	Washington	1	0.1625	May 2005
NJ	Somerset	1	0.13	Jul 1997
NC	Beaufort	1	0.34	Apr 1993
SC	Orangeburg	1	0.48	May 1996
WY	Big Horn	1	0.37	Apr 1999

*Location were listed specifically due to concentration over 1µg/L. Numbers are also bolded.

6.2.1.2. Ground Water Monitoring Data

Criteria	Data
Number of Ground Water Detections	4 (6,408 Total Samples)
Lowest Ground Water Detection	0.005 µg/L (Collier County, FL; April 2009)
Highest Ground Water Detection	0.25 µg/L (Sumter County, GA; September 1993)
Earliest Detection	0.25 µg/L (Sumter County, GA; September 1993)
Latest Detection	0.005 µg/L (Collier County, MS; April 2009)

State	County	Detection Numbers	Concentration (µg/L)	Collection Date Range
FL	Collier	1	0.005	Apr 2009
GA	Sumter	1	0.25	Sep 1993
IN	Delaware, Hancock	2	0.1 – 0.8	Oct 93 – Aug 94

6.2.2. Aldicarb Sulfoxide

6.2.2.1. Surface Water Monitoring Data

Criteria	Data
Number of Surface Water Detections	33 (8,334 Total Samples)
Lowest Surface Water Detection	0.0009 µg/L (Hancock County, IN; July 2010)
Highest Surface Water Detection	**1.91** µg/L (Madison, LA; May 1997)
Earliest Detection	0.92 µg/L (Sumter County, GA; April 1994)
Latest Detection	0.0024 µg/L (St. Mary County, LA; May 2011)

State	County	Detection Numbers	Concentration (µg/L)	Collection Date Range
AL	Madison	14	0.0033-0.1674	Apr 2000 – Apr 2010
CA	San Joaquin	1	0.0047	Feb 2002
CO	Weld	1	0.98	Aug 1994
GA	Sumter	1	0.92	Apr 1994
IN	Hancock	1	0.0009	Jul 2010
LA	Madison	4	0.5 – **1.91**	May 1997
	St. Mary	1	0.0024	May 2011
MS	Warren, Washington	6	0.004 - 0.1009	May 2005 – Jun 2010
OR	Marion	2	0.0042 - 0.008	Jun – Jul 2002
SC	Orangeburg	1	**1.2**	May 1996
NY	Suffolk	1	0.0183	Jul 2007

*Concentrations >1 µg/L are bolded.

6.2.2.2. Ground Water Monitoring Data

Criteria	Data
Number of Ground Water Detections	67 (6,316 Total Samples)
Lowest Ground Water Detection	0.0031 µg/L (Madison County, AL; Jan 2001)
Highest Ground Water Detection	**2.6858** µg/L (Collier County, FL; April 2009)
Earliest Detection	0.42 µg/L (Edgecombe County, NC; August 1993)

Latest Detection	0.0639 µg/L (Madison County, AL; March 2012)

State	County	Detection Numbers	Concentration (µg/L)	Collection Date Range
AL	Autauga, Colbert, Elmore, Lawrence, Limestone, Madison, Montgomery, Tuscaloosa	36	0.0031 - 0.0853	Jun 1999 – Mar 2012
CO	Weld	1	0.43	Mar 1994
CT	Hartford	1	0.007	Aug 1993
FL	Collier, Hendry	5	0.0559 - **2.6858**	Apr – Jun 2009
GA	Miller, Sumter, Tift, Turner, Worth	10	0.0045 - 0.83	Sep 93 – Sep 03
ID	Minidoka	4	0.008 - 0.26	Jun 93 – Jul 05
NJ	Ocean	1	0.23	Sep 1998
NY	Suffolk	1	0.1189	Jul 2007
NC	Edgecombe, Greene, Lenoir	4	0.0367 - 0.42	Aug 93 – Apr 02
SC	Hampton, Lexington	2	0.1061 - 0.14	Jun 97 – Aug 07
TN	Carroll, Madison	2	0.0032 - 0.018	Mar 2011

*Concentrations >1 µg/L are bolded.

6.2.3. Aldicarb Sulfone

6.2.3.1. Surface Water Monitoring Data

Criteria	Data
Number of Surface Water Detections	12 (8,344 Total Samples)
Lowest Surface Water Detection	0.065 µg/L (Madison County, AL; October 2000)
Highest Surface Water Detection	0.1574 µg/L (Denver, CO; April 2002)
Earliest Detection	0.07 µg/L (Washoe County, NV; July 1994)
Latest Detection	0.0059 µg/L (Sarpy County, NE; August 2010)

State	County	Detection Numbers	Concentration (µg/L)	Collection Date Range
AL	Madison	8	0.065 - 0.1035	Apr 2000 – Apr 2010
CO	Denver	1	0.1574	Apr 2002
NE	Sarpy	1	0.0059	Aug 2010
NV	Washoe	1	0.07	Jul 1994
NY	Suffolk	1	0.0287	Jul 2007

6.2.3.2. Ground Water Monitoring Data

Criteria	Data
Number of Ground Water Detections	61 (6,331 Total Samples)
Lowest Ground Water Detection	0.035 µg/L (Hendry County, FL; May 2009)
Highest Ground Water Detection	0.9412 µg/L (Collier County, FL; June 2009)
Earliest Detection	0.32 µg/L (Edgecombe County, NC; August 1993)
Latest Detection	0.0844 µg/L (Limestone County, AL; March 2012)

State	County	Detection Numbers	Concentration (µg/L)	Collection Date Range

AL	Autauga, Colbert, Lawrence, Limestone, Madison, Montgomery, Tuscaloosa	38	0.089 - 0.1592	Jun 1999 – Mar 2012
FL	Collier, Hendry	5	0.0035 - 0.9412	Apr – Jun 2009
GA	Miller, Sumter, Tift, Turner, Worth	8	0.085 - 0.0946	May 95 – Sep 03
ID	Minidoka	1	0.0073	Jul 2005
NY	Suffolk	1	0.1571	Jul 2007
NC	Edgecombe, Greene	3	0.032 - 0.32	Aug 93 – Apr 02
SC	Hampton, Lexington, Sumter	4	0.04 - 0.14	May 97 – Aug 07
TN	Madison	1	0.0094	Mar 2011

6.2.4. USGS NAWQA Monitoring Data Summary

Monitoring data from USGS NAWQA was more extensive than that of USEPA STORET. Results shows that aldicarb was detected predominantly in surface water (54 samples), while sulfone and sulfoxide were mostly in the groundwater (61 & 67 samples). The bulk of the detection frequencies for parent aldicarb in surface water were in the Southeastern U.S., where out of 54 samples, 43 were in Georgia. Except for 2 samples were from the same sites, all of them were from different sampling sites. A few sites in Alabama, specifically Madison County were monitored for aldicarb, sulfone, and sulfoxide in groundwater for once a month from March 2000 to March 2001. The detection frequencies for both aldicarb sulfone and sulfoxide were also in the Southeastern U.S.

USGS NAWQA database follows similar trend to that of USEPA STORET where it is non-targeted monitoring and the timing of monitoring is irregular. Further, the sample collection was not targeted for aldicarb use and the data cannot be correlated with use.

6.3. California Department of Pesticide Regulation (CDPR) Surface Water Database

The CDPR Surface Water Database indicates that aldicarb TTR was analyzed at 293 surface water sites in California at various times from February 1991 to October 2010. A total of 6795 samples were collected. While some sites were sampled for a total of 16 times over the span of 4 years, most of the sites were sampled at least 3 or more times at various times. Aldicarb and its residues were detected in a total of eleven samples, where eight were of parent aldicarb. The earliest detection of aldicarb was in San Joaquin River, Stanislaus in July 1991 and the most recent was in two storm drain samples in Sacramento on August 2009 with the lowest range concentration of 0.084-0.086 μg/L. Aldicarb was detected in the same sampling point twice (Miles Creek, Merced County) with the highest measured concentration of 5.4 μg/L on June 2007 but decreased 10-fold to 0.53 in June 2008. Other detections of aldicarb occurred in Colusa Basin drain, Yolo (0.7 μg/L) on April 2000, Deadman Creek, Merced (1.2 μg/L) on June 2007, and Logan Creek, Colusa (1.5 μg/L) on May 2008.

Aldicarb sulfone was detected in two samples, 0.05 μg/L on August 1991 in San Joaquin River and 0.258 μg/L on February 1992 in Turlock Irrigation District drain, both on Stanislaus County. Meanwhile, sulfoxide was measured in one sample at 0.28 μg/L on July 1991 in San Joaquin River.

6.4. Bayer CropScience Monitoring Studies

In 2006, Bayer CropScience, submitted five retrospective ground water monitoring studies to look for residues of aldicarb and its sulfoxide and sulfone metabolites in potable water from private wells in aldicarb use areas. This study monitored 1,673 drinking water wells and collected information on ground-water depth, well depth, casing depth, well type and age, soil types, recent aldicarb use history, crops, and distance of the well from the treated field. The study sampled drinking water wells in five regions of the country: the Southeastern US (800 wells), the Mississippi Delta (169 wells), the Pacific Northwest (303 wells), Texas (201 wells), and California (200 wells). The study found that aldicarb residues – predominantly the sulfoxide and sulfone metabolites – were detected in 10 percent of the wells sampled. The greatest frequencies of detections were in the Southeastern US (16%, with a maximum detect of 2.9 μg/L) and the Mississippi Delta (9%, with a maximum detect of 2.6 μg/L) regions. Because the single samples represent a snapshot in time, the Agency assumed that the measured concentrations reflected a median concentration for that particular well. Frequency and magnitudes of detection for aldicarb residues were generally greater for wells located within 300 feet of a field (~10% of wells had detections); aldicarb residues were detected in 4-6% of wells located >300 feet from the field, although detections were < 1 μg/L. A comparison of wells located near fields with restricted soils (as identified in the previously registered Temik 15G label) to those where the surrounding fields contained no restricted soils showed that, while the frequency of aldicarb detections was greater for wells near restricted soil types, the magnitude of aldicarb residues was greater for wells with no restricted soil types.

6.5. Monitoring Data Summary

Aldicarb, aldicarb sulfoxide, and aldicarb sulfone were monitored in non-targeted sites for surface and groundwater in all 50 states in the U.S. including the District of Columbia from February 1986 to December 2014. Note that much of this monitoring data was collected prior to mitigation and use reduction associated with reregistration of aldicarb. The mitigation was implemented in 2009.

Concentrations of aldicarb detected in surface water were higher than that of groundwater and inversely, its sulfoxide and sulfone were higher in groundwater than surface water. The highest detections of aldicarb residues of concern in these databases are 5.4 μg/L in surface water (parent aldicarb) and 9.0 μg/L in ground water (sulfone). These concentrations are within an order of magnitude of modeled chronic exposure estimates (5.68 μg/L surface water and 21 μg/L ground water) for aldicarb residues of concern.

Overall, the 2009 mitigation implementation may have caused the decrease in the number of detections and concentrations of aldicarb, aldicarb sulfoxide, and aldicarb sulfone in surface water. However, since the monitoring databases were non-targeted, especially for aldicarb use, the observation cannot be verified by the lack of detections of aldicarb and its residues in surface water samples post 2009. Further, the monitoring results following mitigation has not indicated a clear trend of decline on aldicarb residues concentrations in groundwater. Aldicarb was still detected at 0.64 μg/L on April 2012, aldicarb sulfoxide at 0.3 μg/L on May 2012, and aldicarb sulfone at 0.35 μg/L on May 2012. Hence, the monitoring results further supports the submitted studies and published literatures that aldicarb residues are highly mobile in the soil profile and exhibit persistence in subsurface environment and groundwater.

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7.1. Submitted Environmental Fate and Product Chemistry Studies

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159163	MSD Agvet Inc. (1983) Residue and Environmental Data: [MK-936]. Unpublished compilation. 160 p.
41191501	Wehner, T. (1989) Additional Soil Residue Data in Support of Applications for Registration of Abamectin Soil Leaching and Dissipation Study: Project ID: Merck No. 001-87-6045R; ADC No. 992. Unpublished study prepared by Merck Sharp & Dohme Research Laboratories and Analytical Development Corp. 18 p.
42627601	Wertz, P. (1993) Soil Residue Data in Support of an Application for Registrations of Abamectin: Soil Leaching and Dissipation Study 001-87-6045R: A Supplement: Lab Project Number: 618-936-6045. Unpublished study prepared by Analytical Development Corp. 603 p.
46877502	Friis, M. (2006) Product Chemistry - Abamectin Technical (CHA 204) - EPA Reg. No. 4787 - (none yet) Group B - Physical /Chemical Properties. Project Number: MVF/060500/ABA/204/B/USA, PYC/170, PYC/171. Unpublished study prepared by Cheminova Agro A/S. 399 p.

MRID	Citation Reference
47436204	Wagner, J. (2008) Abamectin Technical Herbicide: Stability to Normal and Elevated Temperatures, Metals, and Metal Ions: Oxidation/Reduction: Flammability: Explodability: Storage Stability: Miscibility: Corrosion Characteristics: Dielectric Breakdown Voltage: Viscosity: Boiling Point: Dissociation Constants in Water: Particle Size, Fiber Length, and Diameter Distribution: Partition Coefficient: Water Solubility: Vapor Pressure. Unpublished study prepared by Wagner Regulatory Associates, Inc. 6 p.
49071001	Phaff, R. (2001) NOA422601 - Soil Photolysis of [23-(Carbon 14] - Labelled NOA422601 (Avermectin B1a) - Under Laboratory Conditions: Final Report. Project Number: TK0176242/OCR, 00RP04. Unpublished study prepared by Syngenta Crop Protection, AG. 85p.
49071002	Morgenroth, U. (2001) NOA422601 - Adsorption/Desorption of [23-(Carbon14)]-NOA422601 (Avermectin B1a) in Various Soils: Final Report. Project Number: TK0176241/OCR, 99MO05. Unpublished study prepared by Syngenta Crop Protection, AG. 83p.
49071004	Buckel, T. (2002) NOA422601: Metabolism and Rate of Degradation of [23-(Carbon 14)] - Labelled NOA422601 (Avermetin B1a) Under Aerobic and Anaerobic Laboratory Conditions in Aquatic Systems: Final Report. Project Number: TK0176250/OCR, 01TB01. Unpublished study prepared by Syngenta Crop Protection, AG. 181p.
49071005	Adam, D. (2001) Aqueous Photolysis of [23-(Carob 14)] - Labelled NOA422601 (Avermectin B1A) Under Laboratory Conditions (Including Amendment No. 1 to Report on Study 01DA01): Final Report. Project Number: TK0176249/OCR, 01DA01. Unpublished study prepared by Syngenta Crop Protection, AG. 104p.
49071006	Adam, D. (2001) NOA422601: Rate of Degradation of [23-(Carbon 14)] - Labelled NOA422601 (Avermectin B1A) in One Soil Under Various Laboratory Conditions at 10 (Degrees Celsius), 20 (Degrees Celsius) and 30 (Degrees Celsius): Final Report. Project Number: TK0176246/OCR, 00DA07. Unpublished study prepared by Syngenta Crop Protection, AG. 92p.
49071007	Nicollier, G. (2001) NOA422601: Metabolism and Rate of Degradation of [23-(Carbon 14)] - Labelled NOA422601 (Avermetin B1a) Under Aerobic and Anaerobic Laboratory Conditions in One Soil at 20 (Degrees Celsius): Final Report. Project Number: TK0176252/OCR, 99AG07. Unpublished study prepared by Syngenta Crop Protection, AG. 158p.
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Appendix A. Model Output Files

[EMBED Package] [EMBED Package]

Appendix B. Regional PCA Refinement

Standard percent cropped areas (PCA) are used as conservative default estimates of the extent of watershed on which agricultural crops of unknown specific PCA are grown (USEPA, 2012*c*). The exposure estimates from PRZM/EXAMS were multiplied by regional PCA factors for HUC-2 watershed basins of the U.S. in order to account for the highest extent of watershed in the regions on which agricultural crops are grown (Effland *et al.*, 1999). **Figure B1** displays the 18 HUC-2 watershed basins of the contiguous U.S. for which regional PCA factors are calculated.

[INCLUDEPICTURE "C:\\..\\..\\My Documents\\Guidance\\PCAs\\PCA Maps\\PCA Watershed regions + states.jpg" * MERGEFORMATINET]

Figure B1. The Eighteen HUC-2 Watershed Basins of the Contiguous United States.

The first step in this process was to use 2002 AgCensus data (*i.e*, dot-density maps) to ascertain the states in which the modeled crops are grown at a density sufficient to be mapped (USDA, 2008a). These data and the geographic limitations imposed by the labels were used to tabulate states per PCA region where aldicarb might be applied to the modeled uses (**Table B1**). The second step was to assign a PRZM/EXAMS scenario for modeling each use-PCA region combination where aldicarb might be applied (**Table B3**). The strategy for assigning surrogate scenarios was to attempt to use current scenarios to represent areas of similar meteorological and agronomic conditions. For uses where there are limited numbers of currently approved scenarios, current scenarios representing areas west of the Rockies were used to represent large regions west of the Rockies that were generally to the south and/or east of the scenario location. Similarly, current scenarios representing areas east of the Rockies were used to represent large regions east of the Rockies that were generally to the south and/or west of the scenario location. However, scenarios representing areas of South Texas or Florida were used to represent the HUC-2 watershed basin in which they are located as well as watershed basins further north where alternative scenarios were less representative.

Following the assignment of model scenarios to each use-PCA region combination, the modeling was conducted and the regional PCA-adjusted 1-in-10-year peak, 1-in-10-year annual average, and 30-year average EDWCs were tabulated for each combination of use and PCA region (**Table B7**), as discussed in the following sections.

Table B1. Aldicarb Labeled Use Summary Table

HUC-2	Basin Name	Soybeans	Cotton	Other Row Crops (tobacco, sugarbeets, peanut)	Vegetables and Ground Fruit
East of Eastern Divide					
1	New England				
2	Mid Atlantic	Soybean	Cotton	Peanuts	
3	South Atlantic	Soybean	Cotton	Peanuts	
Mid-Continent (Mississippi River Basin)					
4	Great Lakes				Dry Beans

5	Ohio	Soybean	Cotton		
6	Tennessee	Soybean	Cotton		
7	Upper Mississippi		Cotton		
8	Lower Mississippi		Cotton	Peanuts	
9	Souris				
10	Missouri		Cotton	Sugarbeets	Dry Beans
11	Arkansas		Cotton	Sugarbeets, Peanuts	Dry Beans
12	Texas Gulf		Cotton	Peanuts	
13	Rio Grande		Cotton	Sugarbeets, Peanuts	Dry Beans
West of Western Divide					
14	Upper Colorado		Cotton	Sugarbeets	Dry Beans
15	Lower Colorado		Cotton		
16	Great Basin		Cotton	Sugarbeets	
17	Pacific Northwest		Cotton	Sugarbeets	Dry Beans
18	California		Cotton	Sugarbeets	Dry Beans

Table B2. DWI PCA Calculations					
HUC-2	**Soybeans**	**Cotton**	**Other Row Crops (tobacco, sugarbeets, peanut)**	**Vegetables and Ground Fruit**	**DWI PCA**
1					
2	0.11	0.06	*0.82		0.82
3	0.2	0.08	*0.52		0.52
4				0.04	0.04
5	0.59	0.02			0.59
6	0.1	0.04			0.1
7		0			0
8			*0.75		0.75
9					
10		0	*1.0	0.02	1
11		0.07	*0.79	0.01	0.79
12		0.21	*0.77		0.77
13		0.01	*0.52	0.01	0.52
14		0	*0.37	0.01	0.37
15		0.04			0.04
16		0	*0.04		0.04
17		0	*0.72	0.01	0.72
18		0.05	*0.74	0.16	0.74

*Default All-Ag PCA (no individual DWI PCA available)

Table B3. PRZM Scenario Identification to each combination of use and HUC-2 region.				
HUC-2	**Soybeans**	**Cotton**	**Other Row Crops (tobacco, sugarbeets, peanut)**	**Vegetables and Ground Fruit**
1				
2	[1]**PA Corn**	**NC Cotton**	**NC Peanuts**	
3	**MS Soybean**	NC Cotton, [2]**MS Cotton**	**NC Peanuts**	
4				**MI Beans**
5	[1,5]**IL Corn**, IN Corn, OH Corn, PA Corn	**NC Cotton**		
6	**MS Soybean**	NC Cotton, [2]**MS Cotton**		
7		**MS Cotton**		
8		**MS Cotton**	**NC Peanuts**	
9				
10		**MS Cotton**	**MN Sugar beets**	**MI Beans**
11		**MS Cotton**	ID Potato, [4]**NC Peanuts**	**MI Beans**
12		**MS Cotton**	**NC Peanuts**	
13		**CA Cotton**	ID Potato, [4]**NC Peanuts**	**OR Sn Beans**
14		**CA Cotton**	[3]**ID Potato**	**OR Sn Beans**
15		**CA Cotton**		
16		**CA Cotton**	[3]**ID Potato**	
17		**CA Cotton**	[3]**ID Potato**	**OR Sn Beans**
18		**CA Cotton**	[3]**ID Potato**	**OR Sn Beans**

* Bold indicate the scenario was selected.

[1] Soybean is rotated with corn in the same field, thus corn scenarios are selected as surrogates for soybeans in their respective HUC 2 region.

[2] MS Cotton is selected over NC Cotton when both share the same HUC2 because MS Cotton provides a more conservative estimate.

[3] Potato scenario were chosen as surrogate in absence of appropriate representation of the HUC region. Potato is a root crop which is deemed similar to that of sugar beets.

[4] NC Peanuts were chosen over ID Potato when both overlapped because the model yielded higher output.

[5] IL Corn was selected because it yielded the highest estimates.

Table B4. Adjusted EDWCs (µg/L) Peak by use and by regional DWI PCA specific to each HUC-2 region							
HUC2	**Soybeans**	**Cotton**	**Other Row Crops (tobacco, sugarbeets, peanut)**	**Vegetables and Ground Fruit**	**MAX EDWCS Peak**	**DWI PCA**	**Adjusted EDWCS Peak**
1							
2	29.5	51.1	50.4		51.1	0.82	**41.90**
3	26.7	84.1	50.4		84.1	0.52	**43.73**
4				73.1	73.1	0.04	**2.92**
5	80.6	51.1			80.6	0.59	**47.55**
6	26.7	84.1			84.1	0.1	**8.41**
7		84.1			84.1	0	**0.00**
8		84.1	50.4		84.1	0.75	**63.08**
9							
10		51.1	187	73.1	187	1	**187.00**
11		84.1	50.4	73.1	84.1	0.79	**66.44**
12		84.1	50.4		84.1	0.77	**64.76**
13		23.1	50.4	70.3	70.3	0.52	**36.56**
14		23.1	11.5	70.3	70.3	0.37	**26.01**
15		23.1			23.1	0.04	**0.92**
16		23.1	11.5		23.1	0.04	**0.92**
17		23.1	11.5	70.3	70.3	0.72	**50.62**
18		23.1	11.5	70.3	70.3	0.74	**52.02**

Table B5. Adjusted EDWCs (µg/L) Annual Average by use and by regional DWI PCA specific to each HUC-2 region							
HUC2	**Soybeans**	**Cotton**	**Other Row Crops (tobacco, sugarbeets, peanut)**	**Vegetables and Ground Fruit**	**MAX EDWCS Annual AVG**	**DWI PCA**	**Adjusted EDWCs Annual AVG**
1							
2	2.92	3.65	4.01		4.01	0.82	**3.29**
3	1.96	5.64	4.01		5.64	0.52	**2.93**
4				7.35	7.35	0.04	**0.29**
5	7.8	3.65			7.8	0.59	**4.60**
6	1.96	5.64			5.64	0.1	**0.56**
7		5.64			5.64	0	**0.00**
8		5.64	4.01		5.64	0.75	**4.23**
9							
10		1.75	16	7.35	16	1	**16.00**
11		5.64	4.01	7.35	7.35	0.79	**5.81**
12		5.64	4.01		5.64	0.77	**4.34**
13		1.75	4.01	6.52	6.52	0.52	**3.39**
14		1.75	1.3	6.52	6.52	0.37	**2.41**
15		1.75			1.75	0.04	**0.07**
16		1.75	1.3		1.75	0.04	**0.07**
17		1.75	1.3	6.52	6.52	0.72	**4.69**
18		1.75	1.3	6.52	6.52	0.74	**4.82**

Table B6. Adjusted EDWCs (µg/L) 30-Year Average by use and by regional DWI PCA specific to each HUC-2 region							
HUC2	**Soybeans**	**Cotton**	**Other Row Crops (tobacco, sugarbeets, peanut)**	**Vegetables and Ground Fruit**	**MAX EDWCS 30-Yr AVG**	**DWI PCA**	**Adjusted EDWCs 30-Yr AVG**
1							
2	0.89	1.71	1.29		1.71	0.82	**1.40**
3	0.578	2.18	1.29		2.18	0.52	**1.13**
4				2.68	2.68	0.04	**0.11**
5	2.21	1.71			2.21	0.59	**1.30**
6	0.578	2.18			2.18	0.1	**0.22**
7		2.18			2.18	0	**0.00**
8		2.18	1.29		2.18	0.75	**1.64**
9							
10		0.45	5.3	2.68	5.3	1	**5.30**
11		2.18	1.29	2.68	2.68	0.79	**2.12**
12		2.18	1.29		2.18	0.77	**1.68**
13		0.45	1.29	1.83	1.83	0.52	**0.95**
14		0.45	0.29	1.83	1.83	0.37	**0.68**
15		0.45			0.45	0.04	**0.02**
16		0.45	0.29		0.45	0.04	**0.02**
17		0.45	0.29	1.83	1.83	0.72	**1.32**
18		0.45	0.29	1.83	1.83	0.74	**1.35**

Table B7. Regional PCA Adjusted EDWCs Summary (µg/L)				
HUC-2	**PCA USED**	**1-in-10 Year Peak**	**1-in-10 year Annual Average**	**30 year Average**
1	0.00	0.00	0.00	0.00
2	0.82	41.90	3.29	1.40
3	0.52	43.73	2.93	1.13
4	0.04	2.92	0.29	0.11
5	0.59	47.55	4.60	1.30
6	0.1	8.41	0.56	0.22
7	0	0.00	0.00	0.00
8	0.75	63.08	4.23	1.64
9	0.00	0.00	0.00	0.00
10	1	187.00	16.00	5.30
11	0.79	66.44	5.81	2.12
12	0.77	64.76	4.34	1.68
13	0.52	36.56	3.39	0.95
14	0.37	26.01	2.41	0.68
15	0.04	0.92	0.07	0.02
16	0.04	0.92	0.07	0.02
17	0.72	50.62	4.69	1.32
18	0.74	52.02	4.82	1.35

Appendix C. List of Vulnerable Soils and Soil Restrictions on Meymik 15G Label

[EMBED Acrobat.Document.11]